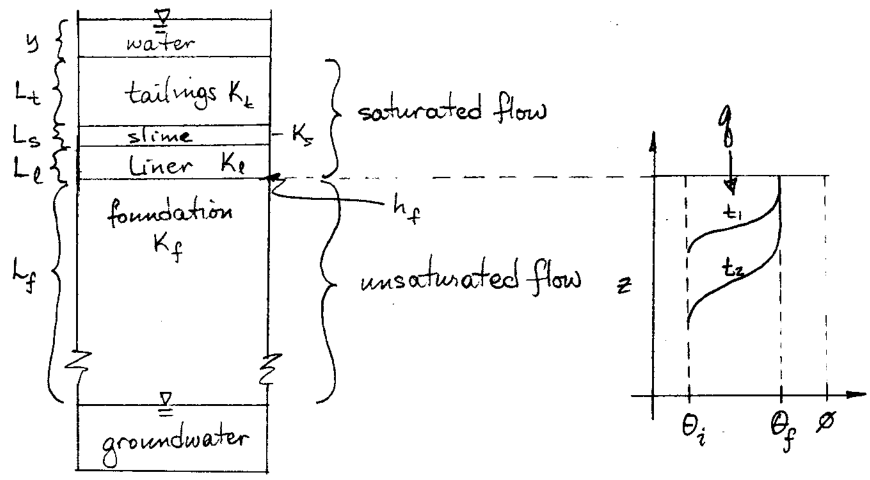
Unsaturated Flow below tailings, or Liquid waste impoundments.

Cross-section definition sketch – Estimate the seepage rate from impdmt.



A. Saturated flow region – flow through layered soils

$$q = \bar{K}\frac{\Delta H}{\Delta z} = \bar{K}\frac{(y+L_t+L_s+L_\ell)-h_f}{L}$$

where $h_f = h_w$ at the liner-foundation boundary

$$\bar{K} = \frac{L}{\frac{L_t}{K_t}+\frac{L_s}{K_s}+\frac{L_\ell}{K_\ell}}$$

substituting then; $L = L_t + L_s + L_\ell$

$$\boxed{q = \frac{(y+L)-h_f}{\frac{L_t}{K_t}+\frac{L_s}{K_s}+\frac{L_\ell}{K_\ell}}}$$

unfortunately h_f is unknown

B. Assumption (Unsat. flow) – for large times (weeks to years) $q \rightarrow K(\theta_f)$ because during infiltration at long times, the gravitational force is the primary driving force, (in other words, $\frac{dh_c}{dz} \rightarrow 0$). Therefore, from the B-C Eqns:

$$K = K_f\left(\frac{h_d}{h_f}\right)^{\eta} \quad \text{and} \quad q \cong K, \text{ rearranging } \boxed{h_f = h_d\left(\frac{K_f}{q}\right)^{1/\eta}}$$

C. Substitute and solve implicitly for q using trial & error beginning with $q = K_f$, or $h_f = h_d$

$$q = \frac{(y+L) - h_d\left(\frac{K_f}{q}\right)^{1/\eta}}{\frac{L_t}{K_t}+\frac{L_s}{K_s}+\frac{L_\ell}{K_\ell}}$$

D. The foundation soil water content is given by

$$\theta_f = (\theta_m - \theta_i)\left(\frac{q}{K_f}\right)^{2/\eta} + \theta_i \quad \text{where } \theta_i \geq \theta_r$$

E. The time required for the seepage water to contact the groundwater is given by

$$t = \frac{L_f}{q}(\theta_f - \theta_i)$$